they bring exceedingly good prices and the growth of this industry has been very rapid. The present citrus districts, as in fact is most of the land in the citrus belt, are above the existing irrigating canals, which in most instances divert all of the water available from the rivers, and are therefore entirely dependent on ground waters for irrigation; and, as the profits from this crop warrant a large expenditure, it is naturally the best market for power for pumping purposes. Aside from citrus fruits, all kinds of high class products, such as deciduous fruits, berries, vegetables, nuts, vines, and alfalfa, are to some extent also irrigated by pumped ground water.

The amount of water required for the irrigation of different products varies to such an extent in the different communities that it is impossible to get any figures which would be at all accurate. The character of the soil is accountable for the difference to a large extent, but the cost of water and the personal equation are accountable to a much larger extent. There is usually a marked tendency to the overuse of water. The duty of irrigation water in California is believed to average about 2 feet in depth in addition to the average rainfall.

In the Imperial Valley, in 1906, 120,000 acres were irrigated and a total average depth of 2.04 feet was used, the main crop being grain. In San Diego County on land planted to citrus fruits an average depth of 1.5 foot was used from 1889 to 1899. Around Los Angeles it is estimated that an average depth of 2.4 feet is used.

In the Modesto and Turlock districts as much as 8 feet to 10 feet in depth was used at the start; but in 1908 the depth varied from 1.2 foot to 3.6 feet. In the Fresno district very little water is applied to the surface of the land at present, the land being subirrigated by seepage from the canals.

The San Joaquin and Sacramento valleys are favorable storage basins for ground waters, as the only outlet is the San Francisco Bay through the narrow straits of Carquinez. The elevation of the Lindsay district, 250 miles away, is about 300 feet, and the ground waters must, therefore, of necessity travel very slowly and be in large quantities.

In determining the policies and the scope of a proposed hydroelectric system for the supply of power for pumped irrigation, it is necessary to determine at the outset the exact territory to be served and the general policies to be followed as regards charges, contracts, extensions, etc., or, in other words, a definite goal must be set, the power company must do everything possible to assist development, and any inhabitant in any section of the territory must be supplied with power whenever it is required. Therefore, the power system simply grows up with the country, and while this growth is taking place (it of necessity must take many years) it must be considered that the power system is in course of construction during the entire period. This is the main feature in which the power project depending entirely upon an irrigation market differs from the project supplying ordinary commercial business in an already well-settled community, and this is a difference which is seldom fully understood and the time element not fully provided for.

SPIDERS AND ANTICYCLONIC WINDS.

By FORD A. CARPENTER, Local Forecaster.

An article on "Bird-Flight and Air-Navigation" in the current number of Century Magazine[1] states that "It was found by a rigid comparison of the birds' movements with the weather map that their flights were invariably started by winds emanating from cyclonic or anticyclonic winds." It has been observed in this locality that spiders also utilize the anticyclonic winds. Whenever the weather map shows a high area over the northwest, the spreading of this area over Washington and Oregon starts the northerly or northeasterly winds flowing down to the so-called permanent low area in southern California, when a close observer may see flying spider webs.

Certain species throw out their thin gossamer silk and, buoyed in the air, are wafted considerable distances. Almost the first indication of the northerly or northeasterly winds (which are popularly termed "desert winds") is the quantity of tiny lengths of spider silk that float in the air. Until the advent of the glass screen to the automobile, these flying webs were annoying to the automobilists, causing irritation to the eyes. The spiders' silky streamers may be seen on the trolley and telephone wires in the early morning of a dry day.

HYDROGRAPHIC DATA OF THE SACRAMENTO RIVER.

Compiled from the records of the United States Geological Survey by W. B. CLAPP, District Engineer.

The Sacramento River is the largest and most important river in California. It drains an area of approximately 27,100 square miles in the north-central part of the State. The boundaries of its drainage basin are determined by the Sierra Nevada and Warner Mountains on the east, Mount Shasta on the north, and the Trinity Mountains and Coast Range on the west. Its length is about 230 miles north and south, with a width of about 150 miles east and west.

The Sacramento River has its source near the south boundary of Siskiyou County, near the town of Sisson, in springs issuing from the western slope of Mount Shasta. It flows southerly for a distance of about 370 miles, finally discharging into Suisun Bay, near Collinsville, about 50 miles by water from San Francisco. The Sacramento, above the mouth of the Pit River, has a length of only about 50 miles and is a comparatively small stream, but its course is through an exceptionally beautiful canyon, its flow being continually increased by water discharging from numerous large springs, among which are the famous Shasta Springs. Below the mouth of the Pit River the Sacramento is a stream of considerable magnitude and is navigable as far north as Red Bluff, about 250 miles from its mouth and 300 miles from San Francisco.

The most important tributaries of the Sacramento River are from the east, and they drain the western slope of the Sierra Nevada. The Pit River is the most important affluent, considering its drainage area and minimum flow. In fact, Pit River is the main stream and the Sacramento River, above its junction with the Pit, is a comparatively small tributary. The principal affluents of the Sacramento below Pit River, in order from north to south, are Cow, Battle, Antelope, Mill, Deer, Chico, and Butte creeks, Feather, Yuba, Bear, and American rivers from the east, and Clear, Cottonwood, Thomes, Stony, Cache, and Puta creeks from the west. Approximately 84 per cent of the Sacramento Basin is mountainous, with many high peaks and ranges and numerous small upland meadow valleys. The other 16 per cent, comprising the gently sloping areas along the lower reaches of the Sacramento River, constitutes what is known as the Sacramento Valley.

The mean annual precipitation in the basin varies with the altitude. It is least on the floor of the valley, where it averages 22 inches, but it increases rapidly in the higher mountain areas, until at elevations of from 3,000 to 5,000 feet occasional annual falls of over 100 inches occur. In the extreme northeastern part of the basin the annual precipitation is comparatively light, even on the higher elevations. The greater part of the annual rainfall comes in the winter months, particularly in December and January, when about 18 and 20 per cent, respectively, of the mean annual rainfall is received. February and March each bring about 13 per cent and November 12 per cent, so that about 76 per cent of the mean annual rainfall occurs in the period November to March, inclusive. April, May, and October furnish 20 per cent more, leaving the other 4 months practically rainless. The precipitation appears chiefly as snow at the higher altitudes. Ordinarily the snow melts slowly, not wholly disappearing until late summer, thus equalizing and extending the stream flow. At times the snow line extends to the lower elevations near the rim of the valley, which, being followed by rising temperature and heavy rains, produces floods of greater or less severity.

The Sacramento Valley probably furnishes the greatest field for development in the United States. The possibilities for irrigation are extensive. Considerable irrigation development has been carried on and the advantages for further irrigation are attracting the attention of capital throughout the United States. Many excellent storage reservoir sites exist in different parts of the Sacramento Basin. The water supply is plentiful, if properly controlled for distribution. The valley suffers from frequent floods which occur in winter and early spring, the worst of recent years occurring in 1904, 1907, and 1909. The total area of the Sacramento Valley is about 4,250 square miles, about 40 per cent of which suffers from floods by overflow.

[1] MacMechen and Dienstbach. "Bird flights and air navigation." Century, Vol. LXXX, p. 297.

The other 60 per cent is high land, not subject to overflow and requiring irrigation for the most successful farming.

TABLE 1.—*Estimated mean monthly discharge of Sacramento River near Red Bluff, Cal., for period 1895–1908.*

Month.	1895.[a]	1896.[b]	1897.[b]	1898.[b]	1899.[b]	1900.[b]	1901.[b]	1902.[c]
January	47,300	46,200	14,300	6,120	13,500	30,700	21,000	5,380
February	26,800	15,500	36,100	12,500	6,650	11,700	34,100	69,200
March	32,500	24,100	21,800	9,740	20,900	23,300	20,600	27,400
April	29,600	25,800	22,800	6,870	10,800	12,100	10,900	22,000
May	30,200	30,900	13,700	6,630	6,910	9,570	9,800	17,800
June	12,800	14,200	7,620	6,670	6,200	5,480	5,600	10,000
July	7,240	7,590	5,700	4,700	4,530	4,210	4,360	6,190
August	6,060	6,390	4,780	4,280	3,990	3,800	3,850	5,670
September	6,320	6,200	4,600	4,280	3,980	3,980	3,920	5,010
October	5,990	6,160	4,960	4,630	5,060	6,380	4,190	5,930
November	6,050	12,000	5,590	4,780	14,500	8,200	7,740	19,800
December	10,100	22,300	7,790	4,990	14,500	15,600	12,100	17,500
Yearly mean	18,400	18,100	12,500	6,350	9,290	11,300	11,500	17,700

Month.	1903.[c]	1904.[c]	1905.[c]	1906.[c]	1907.[c]	1908.[c]	14-year monthly mean.
January	25,600	11,500	31,800	14,700	21,500	21,000	22,200
February	17,200	46,300	26,800	23,200	45,400	23,500	28,200
March	31,600	73,300	30,900	42,500	55,700	15,000	30,700
April	18,800	38,900	18,700	26,300	32,200	12,000	20,600
May	10,900	25,100	12,800	19,400	15,400	10,900	15,700
June	6,970	12,400	8,620	18,100	12,200	7,720	9,610
July	5,590	8,660	6,080	8,530	7,500	5,540	6,170
August	4,960	6,350	5,250	6,330	6,170	4,710	5,180
September	4,810	6,530	5,060	6,020	5,710	4,570	5,070
October	5,350	11,000	5,160	5,870	5,750	5,160	5,830
November	22,000	8,930	5,620	6,570	6,100	6,050	9,570
December	13,100	13,900	6,100	15,400	11,600	6,420	12,200
Yearly mean	13,900	21,900	13,600	16,100	18,800	10,200	14.300

The Water Resources Branch of the United States Geological Survey has maintained gaging stations on the Sacramento River, near Red Bluff, since 1895. During 1895 the gaging station was located at the wagon bridge at the town of Red Bluff. Owing to poor channel conditions, this station was abandoned and a new station established at Jelly's Ferry, some 12 miles above Red Bluff. In January, 1902, the location of the gaging station was again changed. A point in Iron Canyon, about 4 miles above Red Bluff (where the State Engineering Department had made gagings in 1879 and 1893–4), was selected and a cable station constructed. Gagings have been continued at this location since January, 1902. The wettest year was 1904 and the driest 1898. The greatest flood occurred in March, 1907. The total flow during the wettest year was about 4 times that of the driest. The mean monthly flow is greatest in March and least in September. The mean annual flow of all streams in the basin is sufficient to cover the entire Sacramento Valley with water 10 feet in depth.

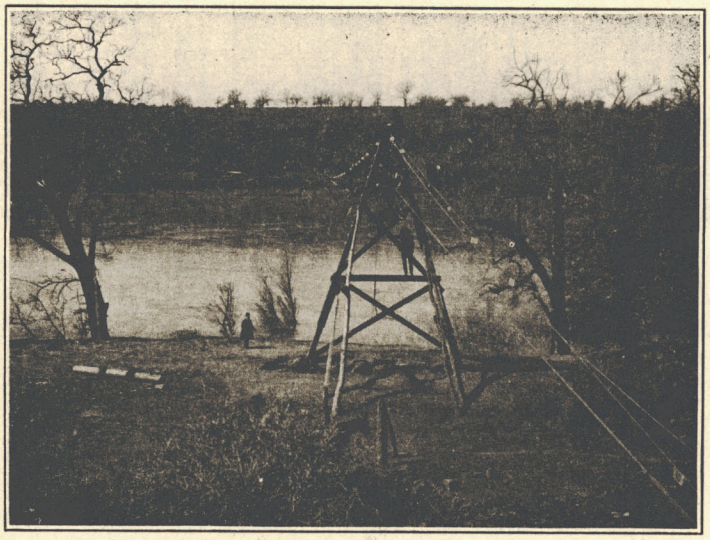
TABLE 2.—*Monthly discharge of Sacramento River near Red Bluff, Cal., for period 1895–1908.*

Drainage area, 9,300 square miles.[d]

Month.	Discharge in cubic feet per second.				
	Maximum.	Minimum.	Mean.	Per square mile.	Run-off on drainage area.
					Inches.
January	131,000[c]	4,760[b]	22,200	2.39	2.76
February	185,000[c]	5,660[c]	28,200	3.03	3.16
March	195,000[c]	6,520[b]	30,700	3.30	3.80
April	71,600[c]	6,520[b]	20,600	2.22	2.48
May	75,100[b]	5,380[b]	15,700	1.69	1.95
June	33,600[c]	4,760[b]	9,610	1.03	1.15
July	11,000[c]	3,800[b]	6,170	.663	.76
August	7,600[c]	3,800[b]	5,180	.557	.64
September	14,500[c]	3,630[b]	5,070	.545	.61
October	45,300[c]	3,800[b]	5,830	.627	.72
November	119,000[b]	4,360[b]	9,570	1.03	1.15
December	93,000[b]	4,700[b]	12,200	1.31	1.51
The period	195,000	3,630	14,300	1.53	20.69

[a] Record kept at highway bridge, Red Bluff.
[b] Record kept at Jellys Ferry, 12 miles above Red Bluff.
[c] Record kept at cable station, Iron Canyon, 4 miles above Red Bluff.
[d] Represents drainage area above cable station, 4 miles above Red Bluff. This area used for computing run-off per square mile.

NOTE.—Discharge in cubic feet per second, completed to three (3) significant figures only. Maximums represent the mean maximum for the day and not peak maximum.



Gaging station, Sacramento River, at Iron Canyon, near Red Bluff, Cal.